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DESCRIPTION

FILM BONDING MACHINE

Technical Field

[0001]

5       The present invention relates to a film bonding machine.  
More particularly, the present invention relates to a film  
bonding machine that can process a tape bonded onto an end  
surface of a honeycomb structural body by laser with  
pinpoint accuracy.

10      Background Art

[0002]

There is an increased necessity to remove fine  
particles and harmful substances contained in exhaust gases  
from boilers and the like in consideration of the adverse  
15      effect of them to the environment. In particular,  
regulations as to removal of fine particles (hereinafter,  
also called PM) exhausted from diesel engines tend to be  
made more strict in Europe and the United States as well as  
in Japan, and a honeycomb structural body is used as a  
20      collecting filter (hereinafter, also called DPF) to remove  
the PM.

[0003]

In general, as shown in Figs. 3(a) and 3(b), the  
honeycomb structural body used as the collecting filter and  
25      the like has such a structure that it includes a plurality

of cells 23, which are partitioned by a porous partition wall 24 and act as fluid flow paths, and adjacent cells 23 are plugged at one ends opposite to each other so that the end surfaces of the cells 23 exhibit a checkered pattern.

5 In the honeycomb structural body 21 having the above structure, a fluid to be treated flows into a cell 23 whose flow-in-hole side end surface 25 is not plugged, that is, a cell 23 whose end portion is plugged on a flow-out-hole side end surface 26 and is exhausted from an adjacent cell 23,  
10 that is, from the cell 23 whose end portion is plugged on the flow-in-hole side end surface 25 and whose flow-out-hole side end surface 26 is not plugged passing through the porous partition wall 24. At the time, the partition wall 24 acts as a filter, and when the honeycomb structural body  
15 is used as the DPF, soot and the like exhausted from diesel engines is trapped by the partition wall 24 and deposited on it.

[0004]

The honeycomb structural body 21 used as described  
20 above has a problem in that a temperature is unevenly distributed in the honeycomb structural body 21 due to the arbitrary change of temperature of an exhaust gas and local heat generation and thus cracks and the like are made in the honeycomb structural body 21. In particular, when the  
25 honeycomb structural body 21 is used as the DPF, it must be

regenerated by burning off accumulated carbon fine particles.  
At the time, the honeycomb structural body 21 is locally  
heated to a high temperature unevenly, from which a problem  
arises in that a regenerating efficiency is lowered and  
5 clacks are liable to be made due to a large amount of  
thermal stress.

[0005]

To cope with the above problems, there are disclosed  
methods of joining segment-like honeycomb structural bodies  
10 (segments) obtained by dividing a honeycomb structural body  
by a joint material (refer to, for example, Patent Document  
1).

[0006]

When the segment-like honeycomb structural bodies are  
15 joined to each other by the joint material, the end surfaces  
of the respective honeycomb structural bodies are protected  
by a resin tape bonded onto them to prevent an extra joint  
material from protruding and entering into the openings of  
cells formed to the respective honeycomb structural bodies.  
20 Further, when silicon carbide (SiC) having a small  
coefficient of thermal expansion is used as the material of  
the honeycomb structural body, a manufacturing method of  
joining segment-like honeycomb structural bodies is also  
used.

25 Patent Document 1: Japanese Patent Publication No. 61-51240

## Disclosure of the Invention

[0007]

However, in a job for bonding a tape onto the end surface of the honeycomb structural bodies since the size and the like of the end surfaces of the honeycomb structural bodies formed in the segment shape are dispersed, a tape (for example, a band-shaped tape) larger than the area of the end surface is bonded onto the end surface of the segment, and the extra portion of the tape is cut off by hand. Accordingly, there is a problem in that a process is complex and a resultant honeycomb structural body is expensive. Further, there is also a problem in that, in the tape bonded onto the end surface of the honeycomb structural body, the ratio of the amount of a tape, which is cut off as an extra portion and discarded, is large as compared with the amount of a substantially used tape.

[0008]

An object of the present invention, which was made in view of the above problems, is to provide a film bonding machine that can process a tape bonded onto the end surface of a honeycomb structural body by laser with pinpoint accuracy.

[0009]

More specifically, the present invention provides the following film bonding machine.

[0010]

[1] In a film bonding machine comprising a laser oscillation means for oscillating laser for processing a tape bonded onto an end surface of a columnar honeycomb structural body by the laser oscillated from the laser oscillation means, the film bonding machine further comprises an image pick-up means having a moving type or tilt type mirror capable of reflecting the end surface of the honeycomb structural body onto the same axis as the laser oscillation means by reflected light and an image pick-up unit for picking up the image of the end surface of the honeycomb structural body reflected on the mirror, wherein the processing position of the tape bonded onto the end surface of the honeycomb structural body can be recognized by the image-pick means on the same axis as the laser oscillation means.

[0011]

[2] A film bonding machine according to [1] further comprises a honeycomb structural body moving means capable of gripping and moving the honeycomb structural body.

[0012]

[3] A film bonding machine according to [1] or [2] further comprises a tape bonding means for bonding the tape onto the end surface of the honeycomb structural body.

[0013]

[4] A film bonding machine according to [3], wherein bonding of the tape onto the end surface of the honeycomb structural body carried out by the tape bonding means, picking-up of the image of the end surface of the honeycomb structural body carried out by the image-pick means, and processing of the tape bonded onto the end surface of the honeycomb structural body carried out by the laser oscillated from the laser oscillation means can be continuously executed by gripping and moving the honeycomb structural body by the honeycomb structural body moving means.

[0014]

[5] A film bonding machine according to any of [1] to [4], wherein the angle of view of the laser oscillation means is approximately the same as the angle of view of the image pick-up unit constituting the image-pick means.

[0015]

[6] A film bonding machine according to any of [1] to [5] further comprises a correction means for correcting the distortion in the laser oscillation means and in the image pick-up unit constituting the image-pick means by segmenting the image obtained by the image pick-up unit.

[0016]

[7] A film bonding machine according to any of [1] to [6], wherein the laser oscillation means is YAG laser, CO<sub>2</sub>

laser, or UV laser.

[0017]

[8] A film bonding machine according to any of [1] to [7], wherein the image pick-up unit is a CCD camera.

5 [0018]

[9] A film bonding machine according to any of [3] to [8], wherein the tape bonding means bonds the band-shaped tape wound in a roll state onto the end surface of the honeycomb structural body while drawing out it by a

10 predetermined amount.

[0019]

[10] A film bonding machine according to any of [1] to [9], wherein the laser oscillation means cuts the tape bonded onto the end surface of the honeycomb structural body along the outer peripheral shape of the end surface thereof.

15

[0020]

[11] A film bonding machine according to any of [1] to [9], wherein the laser oscillation means forms a through hole to the tape bonded onto the end surface of the

20 honeycomb structural body at the predetermined position thereof.

[0021]

Since the film bonding machine of the present invention includes the image-pick means having the mirror capable of reflecting the end surface of the honeycomb structural body

25

by reflected light on the same axis as the laser oscillation means and the image pick-up unit for picking up the image of the end surface of the honeycomb structural body reflected by the mirror, the film bonding machine can recognize the processing position of the tape bonded onto the end surface of the honeycomb structural body by the image picked up by the image-pick means. Accordingly, processing, for example, cutting processing and hole forming processing of the tape bonded onto the end surface of the honeycomb structural body can be carried out by the laser oscillated from the laser oscillation means with pinpoint accuracy. Further, since the film bonding machine of the present invention can use a commercially available laser marker, for example, a galvanomirror scanning type laser marker and the like, the cost of the machine can be reduced.

#### Brief Description of Drawings

[0022]

[Fig. 1(a)] Fig. 1(a) is a front elevational view schematically showing an embodiment of a film bonding machine of the present invention.

[Fig. 1(b)] Fig. 1(b) is a side elevational view of the film bonding machine shown in Fig. 1(a).

[Fig. 2] Fig. 2 is a plan view schematically showing a tape used in the embodiment of the film bonding machine of the present invention.



[Fig. 3(a)] Fig. 3(a) is a perspective view explaining an ordinary honeycomb structural body.

[Fig. 3(b)] Fig. 3(b) is a partially enlarged plan view of an end surface of the honeycomb structural bodies shown in  
5 Fig. 3(a).

#### Reference Numerals

[0023]

1 ... film bonding machine, 2 ... laser oscillation means,  
3 ... image-pick means, 4 ... mirror, 5 ... image pick-up unit, 6  
10 ... honeycomb structural body, 7 ... tape, 8 ... end surface, 9 ...  
tape bonding means, 10 ... draw-out portion, 11 ... winding  
portion, 12 ... honeycomb structural body moving means, 13 ...  
separation paper draw-out unit, 14 ... press unit, 15 ... extra  
tape portion, 16 ... determining press means, 21 ... honeycomb  
15 structural body, 23 ... cell, 24 ... partition wall, 25 ... flow-  
in-hole side end surface, 26 ... flow-out-hole side end  
surface

#### Best Mode for Carrying Out the Invention

[0024]

20 An embodiment of a film bonding machine of the present  
invention will be explained below in detail referring to the  
drawings. However, the present invention should not be  
interpreted so as to be limited to the above embodiment and  
can be variously changed, corrected, and modified based on  
25 the knowledge of the persons skilled in the art as long as

it does not deviates from the scope of the present invention.  
[0025]

Fig. 1(a) is a front elevational view schematically showing the embodiment of the film bonding machine of the present invention, and Fig. 1(b) is a side elevational view of the film bonding machine shown in Fig. 1(a). As shown in Figs. 1(a), 1(b), the film bonding machine 1 of the present invention includes a laser oscillation means 2 for oscillating laser and processes a tape 7 bonded onto an end surface 8 of a columnar honeycomb structural body 6 by the laser oscillated from the laser oscillation means 2. The film bonding machine 1 further includes an image-pick means 3 having a moving type or inclining type mirror 4, which can reflect the end surface 8 of the honeycomb structural body 6 onto the same axis as the laser oscillation means 2 by reflected light, and an image pick-up unit 5 for picking up the image of the end surface 8 of the honeycomb structural body 6 reflected by the mirror 4. Accordingly, it is possible to recognize the processing position of the tape 7 bonded onto the end surface 8 of the honeycomb structural body 6 by the image-pick means 3 on the same axis as the laser oscillation means 2.

[0026]

As described above, the film bonding machine 1 of the present invention subjects the tape 7 bonded onto the end

surface 8 of the columnar honeycomb structural body 6 to cutting processing, hole forming processing, and the like carried out by the laser oscillated from the laser oscillation means 2. Since the film bonding machine 1  
5 includes the image-pick means 3 having the mirror 4 and the image pick-up unit 5 as described above and the mirror 4 of the image-pick means 3 is arranged as the moving type or the inclining type, it can pick up the image of the end surface 8 of the honeycomb structural body 6 on the same axis as the  
10 laser oscillation means 2 and can carry out processings, for example, cutting processing and hole forming processing to the tape 7 bonded onto the end surface 8 of the honeycomb structural body 6 based on an obtained image with pinpoint accuracy. Accordingly, it is possible to reduce the extra  
15 portion (processing margin) of the tape 7 bonded onto the end surface 8 of the honeycomb structural body 6, so that the efficiency of use of the tape 7 can be improved.  
[0027]

Conventionally, a honeycomb structural body composed of  
20 a material such as SiC and the like is manufactured as a large integrated member by bonding the plural segments of quadratic-prism-shaped honeycomb structural bodies. At the time, a tape is bonded onto the end surface of each of the honeycomb structural bodies to prevent a bonding agent in  
25 use from flowing into the cell of the honeycomb structural

body. The film bonding machine 1 of the embodiment can be used to cut the tape bonded onto the end surface of the quadratic-prism-shaped honeycomb structural body with pinpoint accuracy. Further, when a honeycomb structural  
5 body is used as a filter by sealing the openings of predetermined cells formed to the honeycomb structural body, a tape is bonded onto an end surface of the honeycomb structural body, through holes are formed to the predetermined positions of the bonded tape to fill the  
10 openings of the cells with a seal material, and the openings are sealed by filling them with the seal material from the through holes. The film bonding machine 1 of the embodiment can be also preferably used to form the through holes to the tape bonded onto the end surface of the honeycomb structural  
15 body as described above. Accordingly, it is preferable that the laser oscillation means 2 used to the film bonding machine 1 of the embodiment can cut the tape bonded onto the end surface 8 of the honeycomb structural body 6 along the outer peripheral shape of the end surface 8 and can form  
20 through holes at predetermined positions of the tape 7 bonded onto the end surface 8 of the honeycomb structural body 6.

[0028]

In the film bonding machine 1 of the embodiment, the  
25 laser oscillation means 2 is disposed in a vertical

direction with respect to the end surface 8 of the honeycomb structural body 6, and laser can be oscillated from the laser oscillation means 2 vertically to the end surface 8 of the honeycomb structural body 6.

5 [0029]

Further, in Figs. 1(a) and 1(b), the mirror 4 of the image-pick means 3 is tiltably adjustably interposed between the end surface 8 of the honeycomb structural body 6 and the laser oscillation means 2, and the image pick-up unit 5 of  
10 the image-pick means 3 is disposed at a position where it can take the image of the end surface 8 of the honeycomb structural body 6 reflected by the mirror 4 when the mirror 4 is tilted to a predetermined angle.

[0030]

15 YAG laser, CO<sub>2</sub> laser, UV laser, or the like, for example, can be preferably used as the laser oscillation means 2 used in the film bonding machine 1 of the embodiment. When the size of the end surface of the honeycomb structural body is, for example, about 35 mm × 35 mm, the tape 7 bonded onto the  
20 end surface can be cut along the outer peripheral shape of the end surface in about 0.5 to 1.0 second by the use of the laser oscillation means 2. Further, since a commercially available laser marker, for example, a galvanomirror scanning type laser marker and the like can be preferably  
25 used as the laser oscillation means 2, the cost of the film

bonding machine 1 can be reduced.

[0031]

It is preferable that the laser oscillation means 2  
move in the vertical direction with respect to the end  
5 surface 8 of the honeycomb structural body 6 so that it can  
be finely adjusted when processing is carried out by laser.

[0032]

Further, a CCD camera is preferably used as the image  
pick-up unit 5 constituting the image-pick means 3.

10 [0033]

When the tape 7 bonded onto the end surface 8 of the  
honeycomb structural body 6 is processed using the film  
bonding machine 1 of the embodiment, first, the honeycomb  
structural body 6 having the tape 7 bonded onto the end  
15 surface 8 of it is set to the honeycomb structural body 6.  
Next, the mirror 4 of the image-pick means 3 is tilted to a  
predetermined angle so that it is located at a position  
where the image of the end surface 8 of the thus set  
honeycomb structural body 6 is reflected by the mirror 4 and  
20 can be picked up by the image pick-up unit 5, and the image  
of the end surface 8 reflected on the tilted mirror 4 is  
obtained by being picked up by the image pick-up unit 5.  
Next, the tilted mirror 4 is moved to a position where it  
does not interfere the laser oscillated from the laser  
25 oscillation means 2 as well as the tape 7 is processed by

the laser oscillated from the laser oscillation means 2 while controlling the processing position of the tape 7 based on the image obtained by the image-pick means 3. With this arrangement, the laser oscillation means 2 and the  
5 image pick-up unit 5 of the image-pick means 3 are disposed on the same axis, so that processing can be carried out with pinpoint accuracy. For example, when image pick-up carried out by the image-pick means 3 and processing carried out by the laser oscillation means 2 are executed on different axes,  
10 the honeycomb structural body 6 must be moved after the image of the end surface 8 of it is picked up. In this case, accuracy in processing is deteriorated particularly when delicate processing is carried out. Further, in the film bonding machine 1 of the embodiment, since the laser  
15 oscillation means 2 and the image-pick means 3 are disposed on the same axis, the film bonding machine 1 is simplified, reduced in cost, and excellent in maintainability.

[0034]

Further, although not illustrated, the mirror 4 used in  
20 the film bonding machine 1 of the embodiment may be of a moving type. When the mirror is arranged as the moving type, it is previously tilted to a position where it can reflect the end surface of the honeycomb structural body. Accordingly, image pick-up carried out by the image pick-up  
25 unit of the image-pick means and processing carried out by

the laser oscillation means can be executed by simply moving the mirror 4.

[0035]

It is preferable that the film bonding machine 1 of the  
5 embodiment further include a honeycomb structural body  
moving means 12 for gripping and moving the honeycomb  
structural body 6. Specifically, the honeycomb structural  
body moving means 12 grips the honeycomb structural body 6  
before it is processed and moves it to a predetermined  
10 processing position, and then moves it to a different  
position after it is processed. Further, it is preferable  
that the honeycomb structural body moving means 12  
continuously move plural honeycomb structural bodies 6.  
Provision of the honeycomb structural body moving means 12  
15 arranged as described can realize continuous processing and  
reduce running cost.



[0036]

Further, the film bonding machine 1 of the embodiment may further include a tape bonding means 9 for bonding the tape 7 onto the end surface 8 of the honeycomb structural body 6. A tape bonding means for bonding a band-shaped tape 7 wound in a roll state onto the end surface 8 of the honeycomb structural body 6 while drawing out it by a predetermined amount can be preferably used as the tape bonding means 9. Specifically, as shown in, for example, Fig. 1, there is preferably exemplified the tape bonding means 9 including a draw-out portion 10 for drawing out the band-shaped tape 7 wound in the roll state in a predetermined amount and a winding portion 11 for winding the extra portion of the processed tape 7. With this arrangement, not only tapes can be continuously bonded onto plural honeycomb structural bodies 6 using the single band-shaped tape but also the extra portion 15 of the processed tape can be continuously wound as shown in Fig. 2. As a result, the extra tape portion 15 can be simply processed as well as the efficiency of use of the tape 7 can be improved by reducing the amount of extra tape portion 15 by bonding the tape 7 onto the end surface 8 of the honeycomb structural body 6 while drawing out it in the predetermined amount.

[0037]

Although the tape 7 used in the film bonding machine 1 of the embodiment is not particularly limited, a transparent heat shrink tape, for example, can be preferably used.

Further, as shown in Fig. 1(a), a tape having a bonding agent and a separation paper 16 on the surface of it to be bonded can be preferably used. The tape bonding means 9 shown in Fig. 1(a) further includes a separation paper draw-out unit 13 for winding the separation paper 16 of the tape 7. Further, the tape bonding means 9 shown in Fig. 1(a) further includes a press unit 14 for improving an intimate contact property by pressing the tape 7 bonded onto the end surface 8 of the honeycomb structural body 6.

[0038]

When the film bonding machine 1 of the embodiment further includes the honeycomb structural body moving means 12 and the tape bonding means 9 as described above, bonding of the tape 7 onto the end surface 8 of the honeycomb structural body 6 carried out by the tape bonding means 9, picking-up of the image of the end surface 8 of the honeycomb structural body 6 carried out by the image-pick means 3, and processing of the tape 7 bonded onto the end surface 8 of the honeycomb structural body 6 carried out by the laser oscillated from the laser oscillation means 2 are preferably executed continuously by gripping and moving the honeycomb structural body 6 by the honeycomb structural body

moving means 12. With this arrangement, plural honeycomb structural bodies 6 can be continuously processed as well as a time necessary to process the tape 7 bonded onto the end surface 8 of one piece of the honeycomb structural body 6  
5 can be reduced.

[0039]

In the film bonding machine 1 of the embodiment, it is preferable that the angle of view of the laser oscillation means 2 be approximately the same as the angle of view of  
10 the image pick-up unit 5 constituting the image-pick means 3. With this arrangement, there can be reduced an adverse effect caused by a working distance, that is, by the change between the distance from the end surface 8 of the honeycomb structural body 6 to the extreme end portion of a lens of  
15 the laser oscillation means 2 for oscillating laser and the distance from the end surface 8 of the honeycomb structural body 6 to the extreme end portion of a lens of the image pick-up unit 5 for picking up the image of the end surface 8 of the honeycomb structural body 6, so that processing can  
20 be more accurately carried out.

[0040]

It is preferable that the film bonding machine 1 of the embodiment further include a correction means for correcting the distortion in the laser oscillation means 2 and in the  
25 image pick-up unit 5 constituting the image-pick means 3 by

segmenting the image obtained by the image pick-up unit 5.  
An image processing device, which can recognize the  
information obtained from the image pick-up unit 5, for  
example, the CCD camera and the like as a coordinate, can be  
5 exemplified as the correction means.

[0041]

As shown in Fig. 1, the film bonding machine 1 of the  
embodiment may further include a determining press means 16  
for further improving the intimate contact property of the  
10 processed tape 7 to the end surface 8 of the honeycomb  
structural body 6. It is preferable that the determining  
press means 16 have a plate-shaped member for pressing the  
end surface 8 of the honeycomb structural body 6 together  
with the processed tape 7.

15 Examples

[0042]

Although the present invention will be explained below  
more specifically with reference to examples, the present  
invention is by no means limited to them.

20 (Example 1)

[0043]

A film bonding machine 1 as shown in Fig. 1 was  
manufactured which included a laser oscillation means 2 for  
oscillating laser and an image-pick means 3 having a tilt-  
25 type mirror 4 capable of reflecting an end surface 8 of a

cylindrical honeycomb structural body 6 on the same axis as the laser oscillation means 2 by reflected light and an image pick-up unit 5 for picking up the image of the end surface 8 of the honeycomb structural body 6 reflected by the mirror 4. Note that the film bonding machine 1 of the example further included a honeycomb structural body moving means 12 capable of gripping and moving the honeycomb structural body 6 and a tape bonding means 9 for bonding a tape onto the end surface 8 of the honeycomb structural body 6.

[0044]

A commercially available galvanomirror scanning type CO<sub>2</sub> laser was used as the laser oscillation means 2, and a CCD camera was used as the image pick-up unit 5 of the image-pick means 3. The honeycomb structural body 6 was mainly composed of silicon carbide (SiC) and had an end surface whose size was set to 35 mm × 35 mm. A transparent band-shaped heat shrink tape wound in a roll state was used as the tape 7 to be bonded onto the end surface 8 of the honeycomb structural body 6.

[0045]

Processing was continuously carried out to bond the tape 7 onto the end surface 8 of one piece of the honeycomb structural body 6 and cutting the tape 7 along the outer peripheral shape of the end surface 8 by laser. The

processing could be carried out in about 5.8 seconds per one piece of the honeycomb structural body 6. Further, the ratio of the sum of the surface areas of the tape 7 which was cut along the outer peripheral shape of the end surfaces 5 8 of respective honeycomb structural bodies 6 (the value of the sum of the surface areas of the tape 7 excluding the tape discarded as an extra portion) to the overall surface area of the used tape 7 was 55% (hereinafter, the ration is called an "efficiency of use of tape").

10 [0046]

(Comparative Example 1)

Processing was carried out to bond a tape onto the end surface of a honeycomb structural bodiesimilar to that used in the example 1 by hand and to cut the tape along the outer 15 peripheral shape of the end surface of the honeycomb structural body. In the comparative example, about 120 seconds were necessary to process one piece of the honeycomb structural body.

[0047]

20 (Comparative Example 2)

A film bonding machine having a laser oscillation means for oscillating laser and a CCD camera for picking up the image of an end surface of a cylindrical honeycomb structural body on an axis different from the laser 25 oscillation means was manufactured. Processing was carried

out using the film bonding machine to bond a tape onto the  
end surface of the honeycomb structural body using the film  
bonding machine, to pick up the image of the end surface  
using the CCD camera, to move the honeycomb structural body,  
5 and to cut the tape bonded onto the end surface of the  
honeycomb structural body along the outer peripheral shape  
of the end surface on an axis different from the CCD camera  
by the laser oscillated by the laser oscillation means 2.  
In the comparative example 2, a set of four pieces of the  
10 honeycomb structural bodies was processed in one cycle, and  
16 seconds were necessary to carry out processing of the one  
cycle. In the processing, the extra portion of the tape was  
made larger than necessary, and the efficiency of use of  
tape was 33%.

15 Industrial Applicability  
[0048]

The film bonding machine of the present invention can  
carry out processing such as cutting, forming of holes, and  
the like to a tape bonded onto an end surface of a honeycomb  
20 structural body. Accordingly, when the plural segments of a  
quadratic-prism-shaped honeycomb structural body are bonded  
to each other, the film bonding machine can be preferably  
used to process a tape to be bonded to prevent a bonding  
agent in use from flowing into the cells of the honeycomb  
25 structural body (segments). Further, the film bonding

machine can be also preferably used to process a tape used to seal the openings of the cells of the honeycomb structural body.